TELEDYNE LECROY
Everywhereyoulook™

Operator's Manual

HVD3000 / HVD3000A
High-Voltage
Differential Probes

Contents

Warranty

THE WARRANTY BELOW REPLACES ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. TELEDYNE LECROY SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT OR OTHERWISE. THE CUSTOMER IS RESPONSIBLE FOR THE TRANSPORTATION AND INSURANCE CHARGES FOR THE RETURN OF PRODUCTS TO THE SERVICE FACILITY. TELEDYNE LECROY WILL RETURN ALL PRODUCTS UNDER WARRANTY WITH TRANSPORT PREPAID.

The product is warranted for normal use and operation, within specifications, for a period of one year from shipment. Teledyne LeCroy will either repair or, at our option, replace any product returned to one of our authorized service centers within this period. However, in order to do this we must first examine the product and find that it is defective due to workmanship or materials and not due to misuse, neglect, accident, or abnormal conditions or operation.

Teledyne LeCroy shall not be responsible for any defect, damage, or failure caused by any of the following: a) attempted repairs or installations by personnel other than Teledyne LeCroy representatives, b) improper connection to incompatible equipment, or c) use of non-Teledyne LeCroy supplies. Furthermore, Teledyne LeCroy shall not be obligated to service a product that has been modified or integrated where the modification or integration increases the task duration or difficulty of servicing the product. Spare and replacement parts and repairs all have a 90-day warranty.

Products not made by Teledyne LeCroy are covered solely by the warranty of the original equipment manufacturer.

Introduction

The HVD3000 and HVD3000A high-voltage active differential probes are safe, easy-to-use, and ideally suited for power electronics applications where the reference potential is elevated from ground. The probes feature:

- Differential voltage measurement capability in high common-mode environments (up to 6kVrms)
- Exceptional common-mode rejection ratio (CMRR) across a broad frequency range
- Wide differential voltage range
- High offset voltage capability
- 1% DC and low frequency gain accuracy
- AC or DC coupling
- ProBus interface with automatic scaling
- Auto Zero capabilities

The CMRR for the probes is exceptional out to very high frequencies. This greatly assists in measuring signals in the noisy, high common-mode environments of power electronics. High CMRR combined with low probe noise and high offset capability makes the probes capable of measuring very small control signals floating on high common-mode voltages.

The maximum rated differential voltage specifications are provided for using each probe within a wide differential voltage range. The probes will even display signals above the maximum rated differential voltage, up to the maximum measurable differential voltage before saturation limit, although the specifications cannot be guaranteed. Within this range, the probe is operating below the saturation point of the amplifier, and very reasonable results can be expected.

Note: HVD3000A probes are fitted with detection circuits that will indicate when the differential or common mode voltages are beyond the operating ranges of the probe. A warning will be displayed in the oscilloscope message bar.

The probes are calibrated for high-precision measurements to within 1% at DC to low frequency (~10 kHz). This provides for high accuracy of top and base voltage levels of pulse-width modulated signals. The Auto Zero capability permits further measurement precision by allowing small offset drifts to be calibrated out of the measurement.

The ProBus interface makes the probe an integral part of the oscilloscope. Power is provided to the probe through the interface, so there is no need for a separate power supply or batteries. Attenuation may be either automatically selected based on the oscilloscope gain range (V/div) setting, with the offset adjust unified with that of the oscilloscope, or locked to the maximum attenuation setting.

Maximum offset depends on the V/div setting and the oscilloscope model. In general, Teledyne LeCroy 12-bit High Resolution Oscilloscopes (HRO) and HD4096 High Definition Oscilloscopes (HDO) provide the most offset capability over the widest range of V/div settings.

Compatibility

HVD3000 and HVD3000A probes are compatible with most Teledyne LeCroy MAUI oscilloscopes equipped with the ProBus interface. See the HVD3000 product page on our website for all compatible oscilloscope models.

Some legacy oscilloscopes, such as WavePro 7000A and WaveSurfer XS, can be made compatible with HVD3000 probes if upgraded to the Windows XP Professional operating system and requisite firmware. Contact your regional service center regarding upgrades.

Required Firmware

Proper functioning of the HVD3000 and HVD3000A probes requires a minimum version of the XStreamDSO™ firmware to be installed on the oscilloscope:

- The HVD310x probes require firmware version 7.4.x.x or greater.
- The HVD3206 and HVD3605 probes require firmware version 7.8.x.x or greater.
- All HVD3xxxA probes require firmware version 8.5.1.0 or greater.

Safety

To maintain the probe in a correct and safe condition, observe generally accepted safety procedures in addition to the precautions specified in this section. The overall safety of any system incorporating this product is the responsibility of the assembler of the system.

Symbols

These symbols appear on the probe and accessories or in this manual to alert you to important safety considerations.

	**WARNING, HIGH VOLTAGE.** Risk of electric shock or burn.
	**CAUTION** of damage to probe or instrument, or **WARNING** of hazard to health. Attend to the accompanying information to protect against personal injury or damage. Do not proceed until conditions are fully understood and met.
	**ESD CAUTION.** Risk of Elecstostatic Discharge (ESD) that can damage the probe or instrument if anti-static measures are not taken.

Precautions

WARNING. To avoid personal injury or damage due to electric shock orfire:

Do not overload; observe all terminal ratings. Do not apply any potential that exceeds the maximum rating of the probe and/or the probe accessory, whichever is less.

Comply with the Voltage vs. Frequency derating curve when measuring higher frequency signals.

Connect and disconnect properly. Always connect the probe input lead to the probe accessories before connecting to a voltage source. Ensure the connections are secure before applying voltage. Do not disconnect leads or accessories from a live circuit.

Keep the probe body and output cable away from the circuits being measured. Only accessory tips are intended for contact with electrical sources.

Use only accessories compatible with the probe. Use only accessories that are rated for the application. Substituting other accessories than those specified in this manual may create a shock /burn hazard.

Keep fingers behind the finger guard of the probe accessories.

Do not remove the probe's casing. Touching exposed connections may result in electric shock or burn.

CAUTION. To prevent damage to the equipment:

Use only as specified. The probe is intended to be used only with compatible Teledyne LeCroy instruments. Use of the probe and/or the equipment it is connected to in a manner other than specified may impair the protection mechanisms.

Do not bend cables excessively.

Use only within the operational environment listed. Do not use in wet or explosive atmospheres.

Keep product surfaces clean and dry.

Do not operate with suspected failures. Before each use, inspect the probe and accessories for any damage such as tears or other defects in the probe body, cable jacket, accessories, etc. If any part is damaged, cease operation immediately and sequester the probe from inadvertent use.

Operating Environment

Temperature, Operating	0 C to 50 C
Temperature, Non-operating	40 C to 70 C
Relative Humidity, Operating	5% to 80% RH (Non-Condensing) 45% RH above 30 C
Relative Humidity, Non-operating	5% to 95% RH (Non-Condensing) 75% RH above 30 C 45% RH above 40 C
Altitude	3000 m (9842 ft.) max. Derated to 2000 m (6561 ft.) when used with clip accessories
Usage	Indoors

Voltage Derating for Accessories

Accessory	Part Number	Derated Max. Input Voltage for Combined Probe & Accessory (either input to ground)*
Spade Terminals	PK-HVA-05	1000 V CAT III
Safety Alligator Clips	PK-HVA-01	1000 V CAT III
Plunger Alligator Clips	PK-HVA-04	1000 V CAT III
Plunger Pincer Clips	PK-HVA-02	1000 V CAT II
Plunger Hook Clips	PK-HVA-03	1000 V CAT II
6kV Alligator Clips	PK-HVA-06	6000 V CAT I ** 1000 Vrms CAT III 1500 Vdc CAT III
2kV Plunger Alligator Clips	PK-HVA-07	2000 V (DC + Peak AC) CAT I ** 1000 Vrms CAT III 1500 Vdc CAT III

* See "IEC/EN 61010-031 Definitions" on p.38.

** CAT I per IEC/EN 61010-031/A1:2008. No Rated Measurement Category per IEC/EN 61010-031:2015.

CAUTION. The operating altitude of the probe is derated to 2000 m (6560 ft) when used with the above accessories.

WARNING. Each accessory has a different measurement (overvoltage) category (CAT) rating. The voltage and CAT rating of the probe are derated to the values in the table above when used with the corresponding accessory.

WARNING. While all probes may be used with the HVD310x accessories (spade terminals, plunger clips, etc.), the voltage and CAT ratings of the probe are derated to the values in the table above when used with the corresponding accessory.

WARNING. To avoid risk of electric shock or fire, do not exceed either the voltage rating or category rating. Keep your fingers behind the finger guard of the probe. Keep the probe body and output cable away from the circuits being measured. Use only the specified accessories.

HVD310x and HVD310xA Probes

Probe Kit

The probes are delivered with the following:

Item	Description	Safety Rating*	Part Number	QTY
Spade Terminals (1)	Designed to connect to terminal strips, posts and screws, the overall length is 63 mm (2.48 inches). 4 mm Banana (female) connector. 1 ea. red/black.	Insulated 1000 V CAT III	PK-HVA-05	2
Safety Alligator Clips (2)	Designed to reliably grip large components, such as bus bars and large bolts, the overall length is 92.8 mm (3.65 inches) and the jaw opens to 32 mm (1.26 inch). Only the lower jaw is conducive; the top jaw is insulating plastic. 4 mm Banana (female) connector.1 ea. red/black.	Insulated 1000 V CAT III	PK-HVA-01	2

Item	Description	Safety Rating*	Part Number	QTY
Plunger Alligator Clips (3)	The clip is designed to securely grasp thick wires, cables, ground leads, rails, and screw heads. The overall length is 153 mm (6.02 inches); the jaw opens to 23 mm (0.905 inch) max. 4 mm Banana (female) connector. 1 ea. red/black.	Insulated 1000 V CAT III	PK-HVA-04	2
Plunger Pincer Clips (4)	Designed with a long, thin, flexible stem for attaching to hard-to-reach test points, the entire body is fully insulated. The overall length is 161.6 mm (6.36 inch). The pincers can grab leads, pins and wires up to 4 mm (0.157 inch) in diameter. 4 mm Banana (female) connector. 1 ea. red/black.	Insulated 1000 V CAT II	PK-HVA-02	2
Plunger Hook Clips (5)	Designed with a flexible stem to access deep targets in dense environments and a 4.5 mm (0.177 inch) hook to attach to wire leaded parts. The overall length is 157.6 mm (6.20 inches). 4 mm Banana (female) connector. 1 ea. red/black.	Insulated 1000 V CAT II	PK-HVA-03	2
Case	Soft storage case.		SAC-01A	1
Foam	Custom foam insert for storage case.		HVD3106 924228-00 HVD3106-6M 925473-00	1
Operator's Manual			NA	1

* See "IEC/EN 61010-031 Definitions" on p.38 for measurement category definitions.

‡ See "Replacement Parts" on page 32 for information about ordering replacement accessories.

NOTE: The *-NOACC options offer the probe without the accessories.

WARNING. To avoid injury or death due to electric shock, do not handle probe input leads connected to the Spade Terminals while they are connected to a voltage source. Do not use Spade Terminals as hand-held accessories; they are meant to be used as a permanent installation in a test set up.

HVD310x / HVD310xA Specifications

For the current specifications, see the product datasheet a Below are some key product specifications.

Specifications are subject to change without notice.

GUARANTEED SPECIFICATIONS

	HVD3102/ HVD3102A	HVD3106/ HVD3106A	HVD3106-6M/ HVD3106A-6M
Bandwidth (probe only)	25 MHz	120 MHz	80 MHz
Risetime 10-90 %	14 ns	2.9 ns	4.4 ns
CMRR Test Limits, 23 C	80 db @ 50 Hz 60 db @ 1 MHz	80 db @ 50 Hz 60 db @ 1 MHz	80 db @ 50 Hz 60 db @ 1 MHz

ELECTRICAL CHARACTERISTICS (ALL PROBES)

Max. Rated Diff. Voltage (between each input)	1500 V (DC + Peak AC)
Max. Measurable Diff. Voltage (before saturation)	2000 V (DC + Peak AC)
Max. Common Mode Voltage (either input to ground)	± 1500 V (DC + Peak AC) 1000 Vrms
Max. Input Voltage to Earth (either input to ground)	± 1500 Vpk
Max. Safe Input Voltage* (per IEC 61010-031)	1000 Vrms CAT III
Pollution Degree *	2

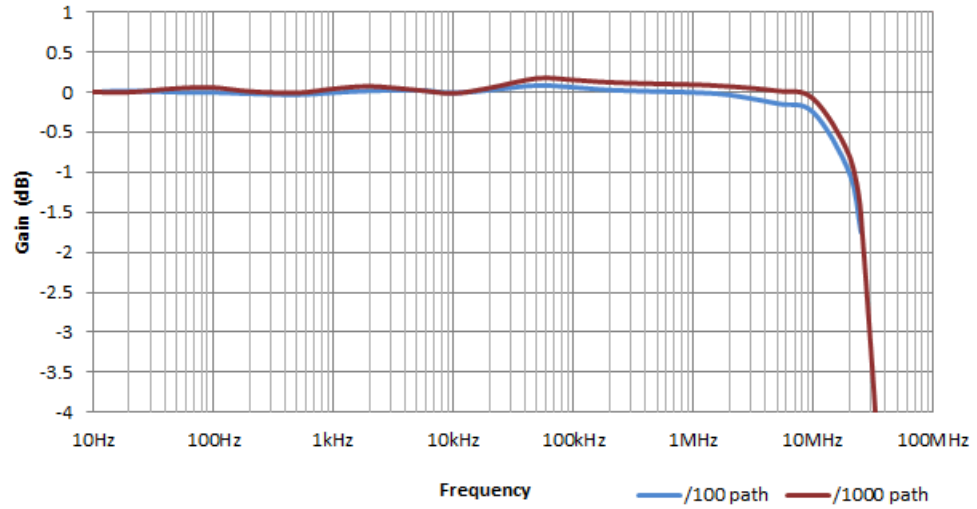
* See "IEC/EN 61010-031 Definitions" on p.38.

VERTICAL SENSITIVITY (ALL PROBES)

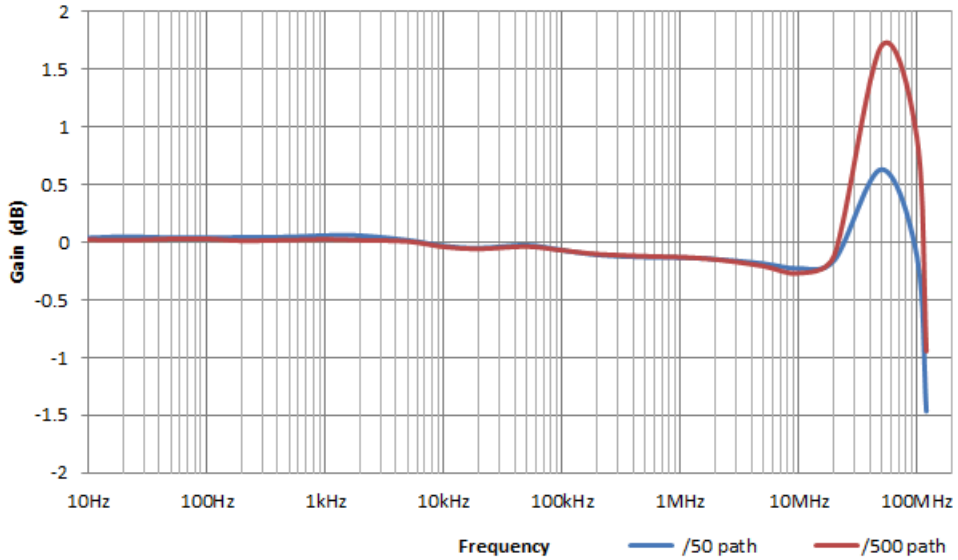
100 mV/Div to 500 V/Div.

HVD310x / HVD310xA Bandwidth

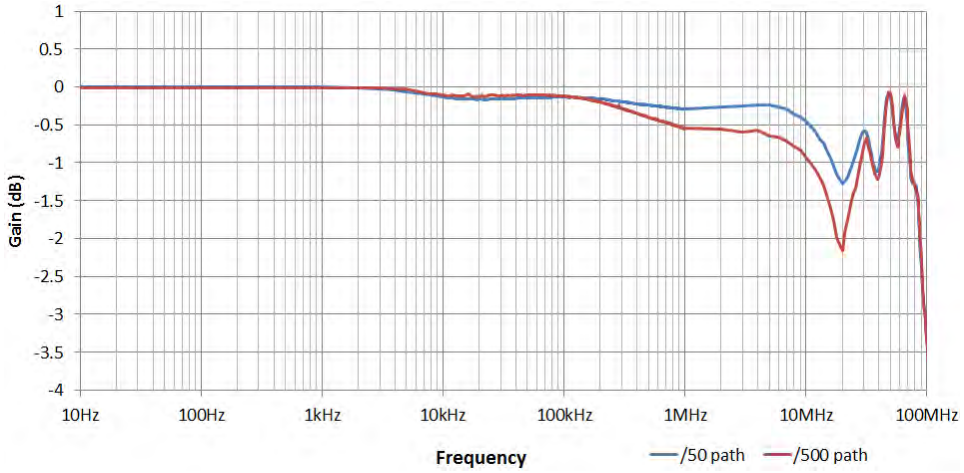
HVD3102 / HVD3102A Typical Bandwidth



HVD3106 / HVD3106A Typical Bandwidth

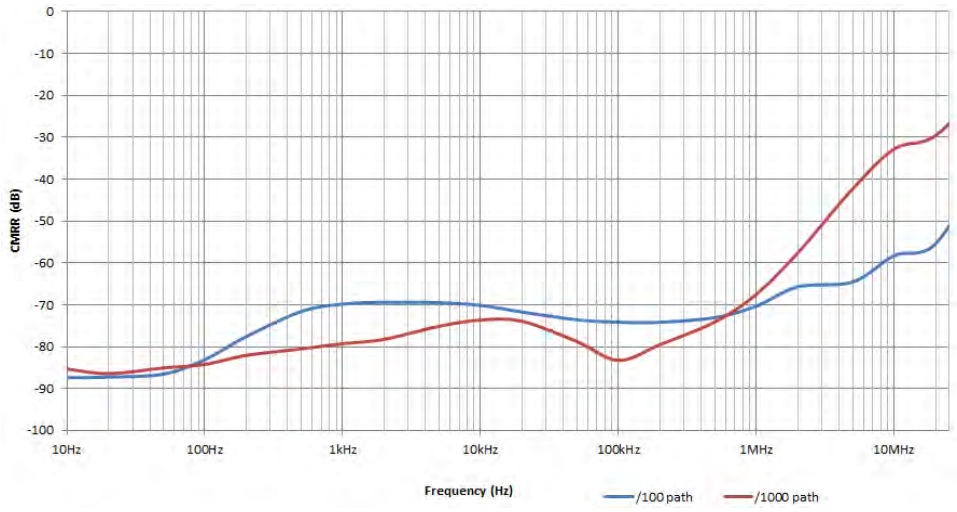


HVD3106-6M / HVD3106A-6M Typical Bandwidth

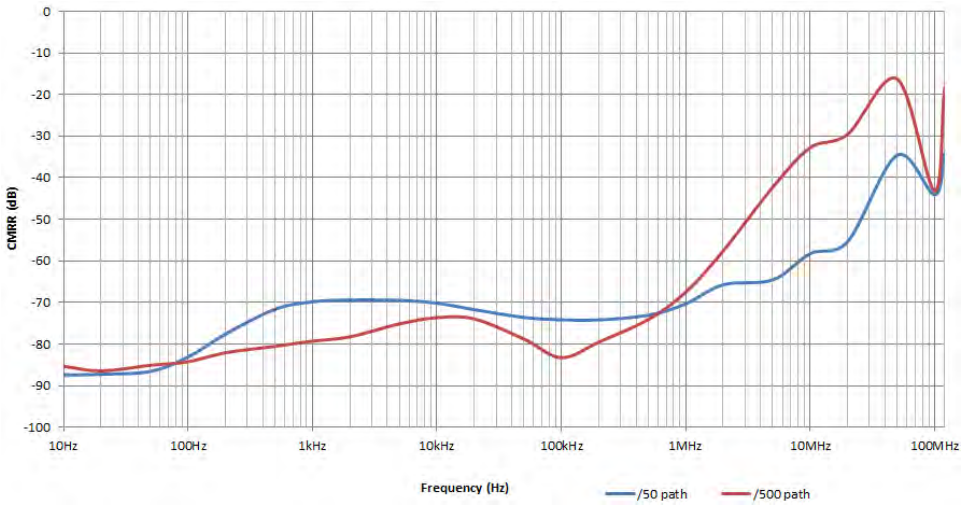


HVD310x / HVD310xA Common Mode Rejection Ratio

HVD3102 / HVD3102A Typical CMRR Performance



HVD3106 / HVD3102A Typical CMRR Performance

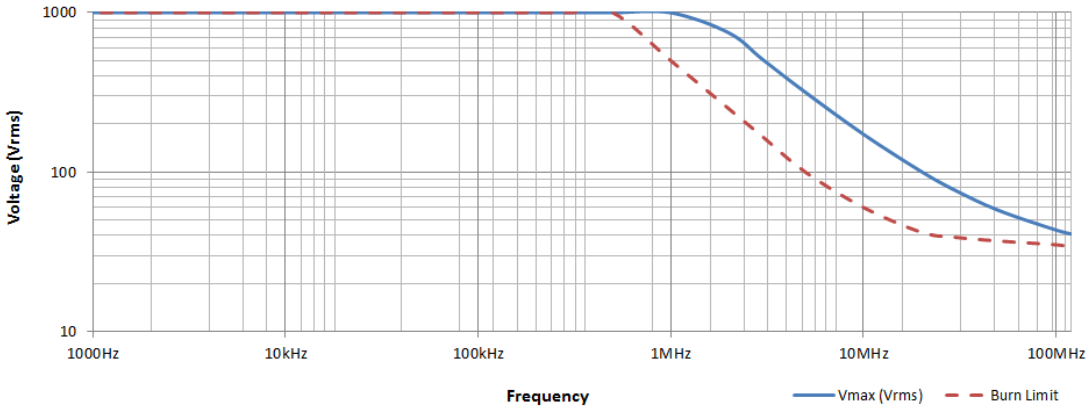


HVD310x / HVD310xA Voltage Derating and Burn Limit

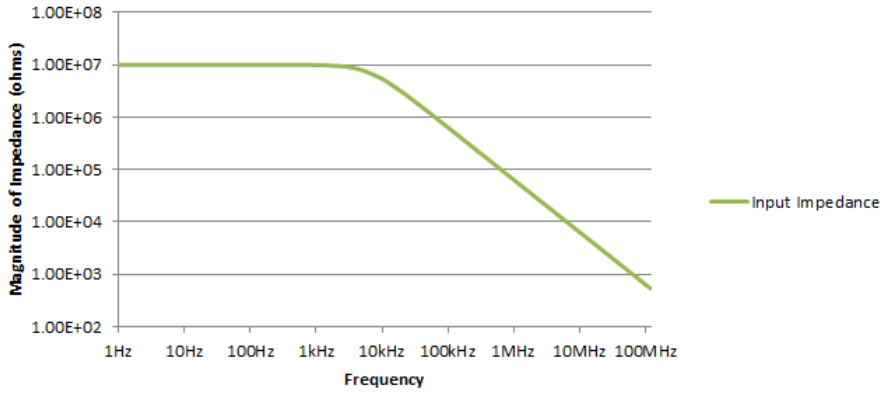
The Maximum Input Voltage curve (solid line) shows the maximum voltage that can be applied to the probe inputs without risking damage to the probe.

The lower Burn Limit curve (dashed line) shows the maximum voltage that can be applied to the probe inputs while the operator is handling the inputs. Handling the inputs while connected to active signals above this burn limit could result in injury to the operator.

WARNING. To avoid risk of electric shock or fire, comply with the burn limit when measuring high-frequency signals with hand-held accessories. Do not exceed the voltage or category rating of the probe or accessories (whichever is less). Keep your fingers behind the finger guard of the probe. Keep the probe body and output cable away from the circuits being measured. Use only the specified accessories.



HVD310x / HVD310xA Differential Input Impedance



HVD3206 and HVD3206A Probes

Probe Kit

The probes are delivered with the following:

Item	Description	Safety Rating*	Part Number‡	QTY
2kV Plunger Alligator Clips	The clip is designed to securely grasp thick wires, cables, ground leads, rails, and screw heads. The overall length is 130 mm (5.1 inches); the jaw opens to 20 mm (0.79 inch) maximum. 4 mm Banana (female) connector. 1 ea. red/black.	2000 V (DC+Peak AC) CAT I** 1000 Vrms CAT III 1500 Vdc CAT III	PK-HVA-07	2
Case	Soft storage case		SAC-01A	1
Foam	Custom foam insert for storage case		925955-00	1
Operator's Manual			NA	1

* See "IEC/EN 61010-031 Definitions" on p.38.

** CAT I per IEC/EN 61010-031/A1:2008. No Rated Measurement Category per IEC/EN 61010-031:2015.

‡ See "Replacement Parts" on page 32 for information about ordering replacement accessories.

HVD3206 / HVD3206A Specifications

For the current specifications, see the product datasheet at Below are some key product specifications.

Specifications are subject to change without notice.

GUARANTEED SPECIFICATIONS

	HVD3206/ HVD3206A	HVD3206-6M/ HVD3206A-6M
Bandwidth (probe only)	120 MHz	80 MHz
Risetime 10-90%	2.9 ns	4.4 ns
CMRR Test Limits, 23 C	80 db @ 50 Hz 60 db @ 1 MHz	80 db @ 50 Hz 60 db @ 1 MHz

ELECTRICAL CHARACTERISTICS (ALL PROBES)

Max. Rated Diff. Voltage (between each input)	2000 V (DC + Peak AC)
Max. Measurable Diff. Voltage (before saturation)	2000 V (DC + Peak AC)
Max. Common Mode Voltage (either input to ground)	± 2000 V (DC + Peak AC) 1000 Vrms
Max. Input Voltage to Earth (either input to ground)	± 2000 Vpk (nominal, either input to ground) ± 2000 Vpk 2000 V (DC + peak AC) CAT I **
Max. Safe Input Voltage* (per IEC 61010-031)	1000 Vrms CAT III 1500 Vdc CAT III
Pollution Degree*	2

* See "IEC/EN 61010-031 Definitions" on p.38

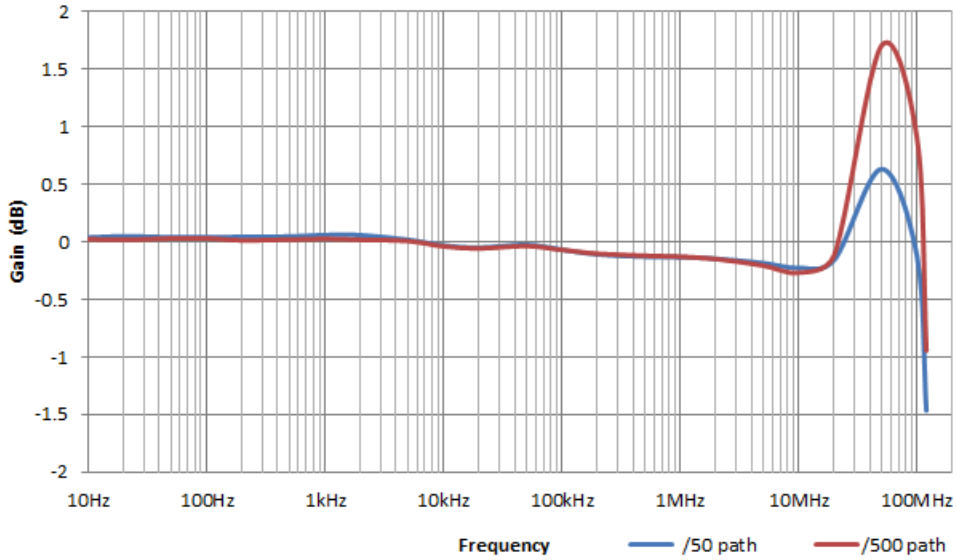
** CAT I per IEC/EN 61010-031/A1:2008. No Rated Measurement Category per IEC/EN 61010-031:2015.

VERTICAL SENSITIVITY (ALL PROBES)

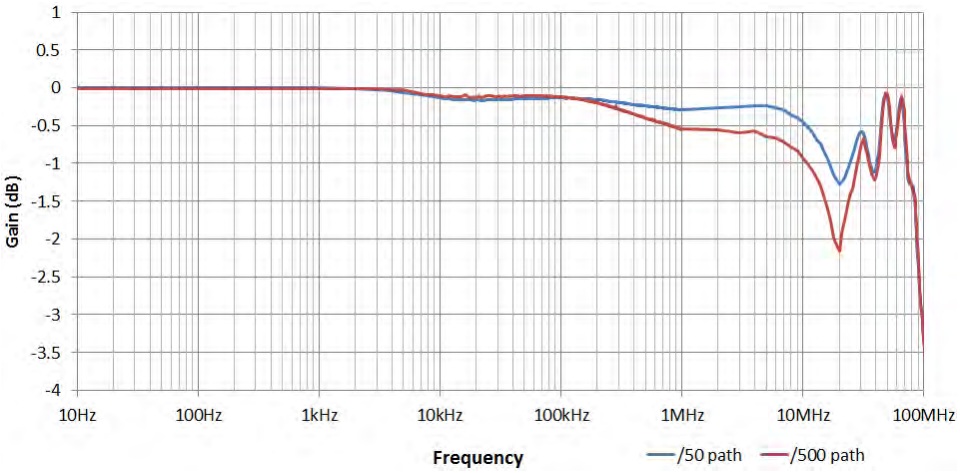
100 mV/Div to 500 V/Div.

HVD3206 / HVD3206A Bandwidth

HVD3206 / HVD3206A Typical Bandwidth

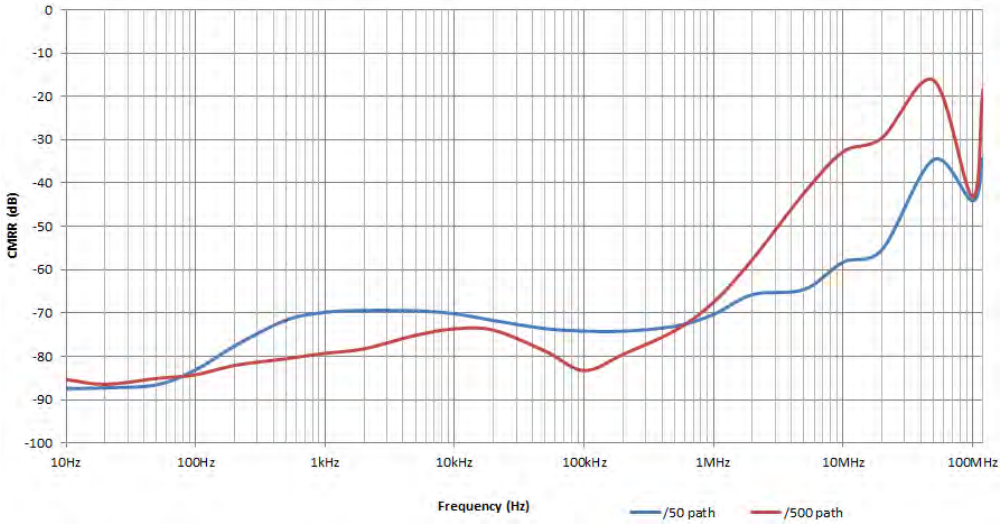


HVD3206-6M / HVD3206A-6M Typical Bandwidth



HVD3206 / HVD3206A Common Mode Rejection Ratio

TYPICAL CMRR PERFORMANCE

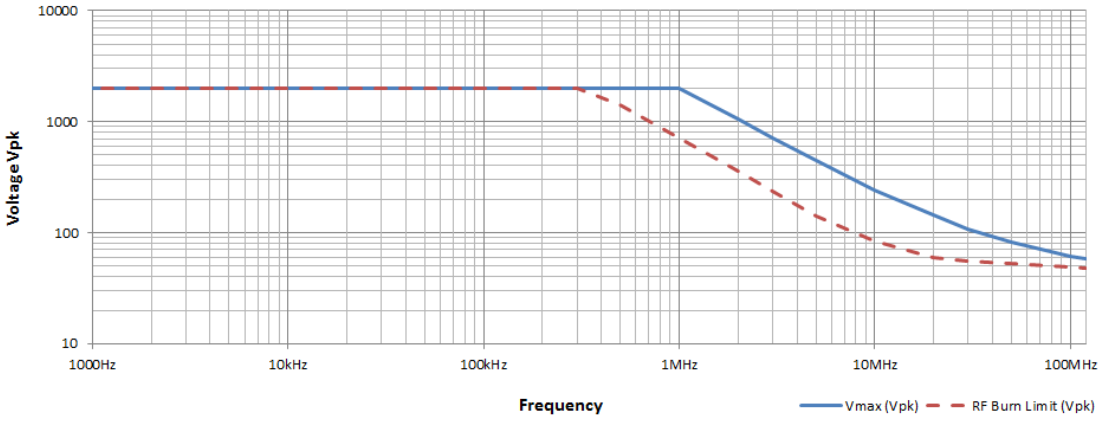


HVD3206 / HVD3206A Voltage Derating and Burn Limit

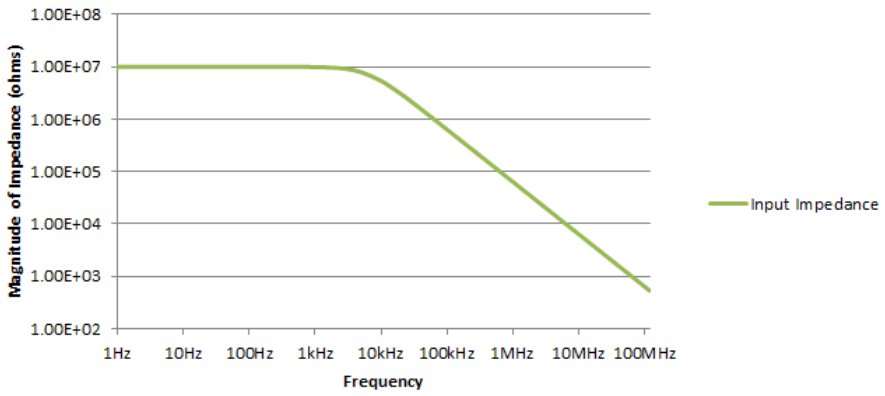
The Maximum Input Voltage curve (solid line) shows the maximum voltage that can be applied to the probe inputs without risking damage to the probe.

The lower Burn Limit curve (dashed line) shows the maximum voltage that can be applied to the probe inputs while the operator is handling the inputs. Handling the inputs while connected to active signals above this burn limit could result in injury to the operator.

WARNING. To avoid risk of electric shock or fire, comply with the burn limit when measuring high-frequency signals with hand-held accessories. Do not exceed the voltage or category rating of the probe or accessories (whichever is less). Keep your fingers behind the finger guard of the probe. Keep the probe body and output cable away from the circuits being measured. Use only the specified accessories.



HVD3206 / HVD3206A Differential Input Impedance



HVD3605 and HVD3605A Probes

Probe Kit

The probes are delivered with the following:

Item	Description	Safety Rating*	Part Number‡	QTY
6kV Alligator Clips	Designed to reliably grip large components, such as bus bars and large bolts, the overall length is 116 mm (4.57 inches) and the jaw opens to 22 mm (0.87 inch). 1 ea. red/black.	6000 V CAT I** 1000 Vrms CAT III 1500 Vdc CAT III	PK-HVA-06	2
Case	Soft storage case		SAC-01A	1
Foam	Custom foam insert for storage case.		925955-00	1
Operator's Manual			NA	1

* See "IEC/EN 61010-031 Definitions" on p.38.

** CAT I per IEC/EN 61010-031/A1:2008. No Rated Measurement Category per IEC/EN 61010-031:2015.

‡ See "Replacement Parts" on page 32 for information about ordering replacement accessories.

HVD3605 / HVD3605A Specifications

For the current specifications, see the product datasheet at Below are some key product specifications.

Specifications are subject to change without notice.

GUARANTEED SPECIFICATIONS

	HVD3605/ HVD3605A
Bandwidth (probe only)	100 MHz
Risetime 10-90%	4.3 ns
CMRR Test Limits, 23 C	80 db @ 50 Hz 60 db @ 10 KHz 60 dB @ 1 MHz (200x) 46 dB @ 1 MHz (2000x)

ELECTRICAL CHARACTERISTICS (ALL PROBES)

Max. Rated Diff. Voltage (between each input)	7000 V (DC + Peak AC)
Max. Measurable Diff. Voltage (before saturation)	7600 V (DC + Peak AC)
Max. Common Mode Voltage (either input to ground)	± 7600 V (DC + Peak AC) 6000 Vrms
Max. Input Voltage to Earth (either input to ground)	± 7600 Vpk (nominal, either input to ground) ± 8485 V (DC + peak AC) CAT I **
Max. Safe Input Voltage* (per IEC 61010-031)	6000 Vrms CAT III 1000 Vrms CAT III 1500 Vdc CAT III
Pollution Degree*	2

* See "IEC/EN 61010-031 Definitions" on p.38

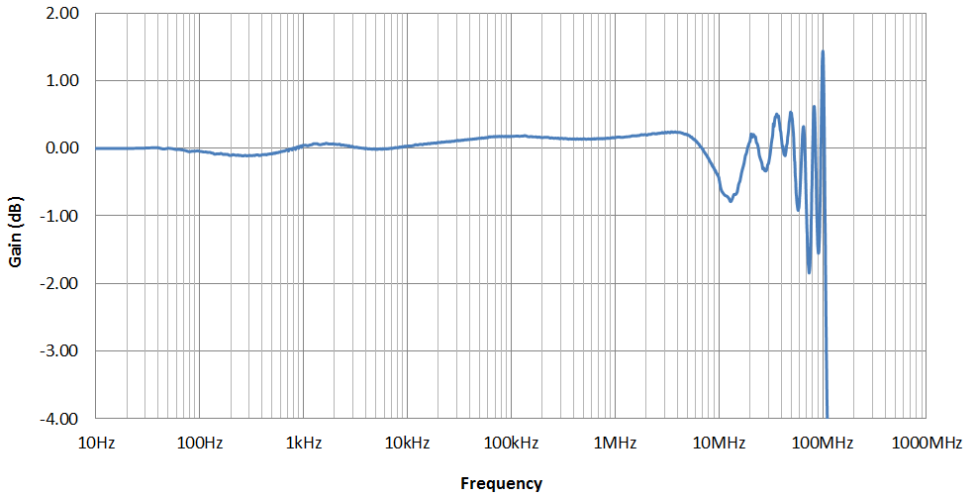
** CAT I per IEC/EN 61010-031/A1:2008. No Rated Measurement Category per IEC/EN 61010-031:2015.

VERTICAL SENSITIVITY (ALL PROBES)

300 mV/Div to 2000 V/Div.

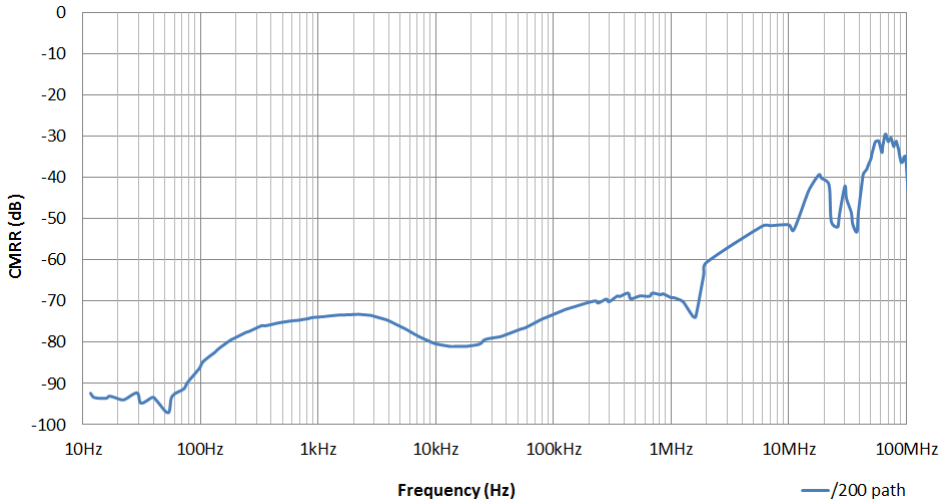
HVD3605 / HVD3605A Bandwidth

TYPICAL BANDWIDTH



HVD3605 / HVD3605A Common Mode Rejection Ratio

TYPICAL CMRR PERFORMANCE

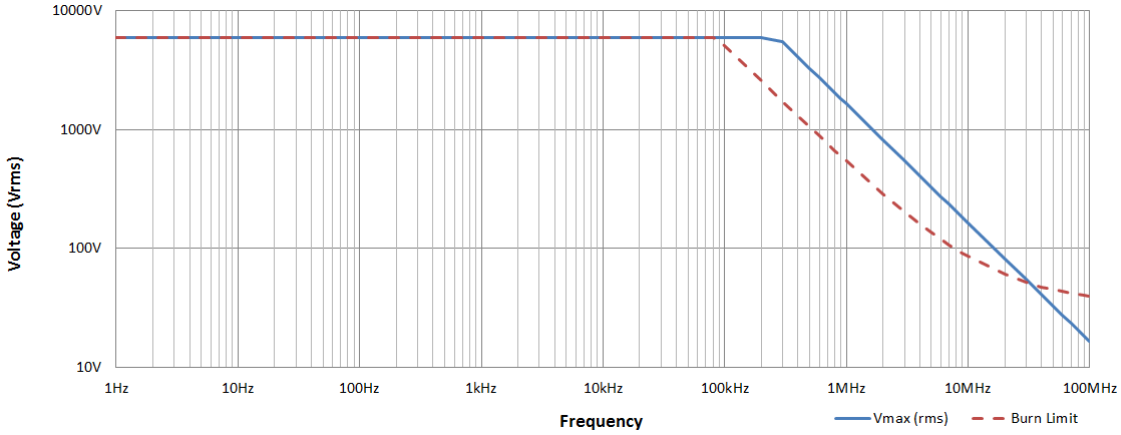


HVD3605 / HVD3605A Voltage Derating and Burn Limit

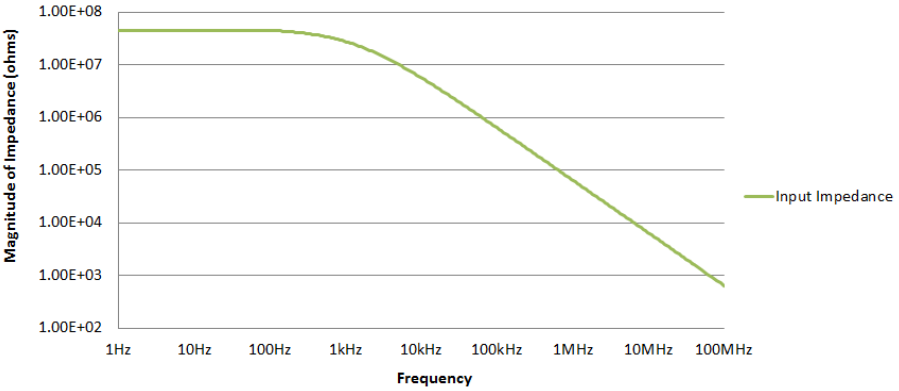
The Maximum Input Voltage curve (solid line) shows the maximum voltage that can be applied to the probe inputs without risking damage to the probe.

The lower Burn Limit curve (dashed line) shows the maximum voltage that can be applied to the probe inputs while the operator is handling the inputs. Handling the inputs while connected to active signals above this burn limit could result in injury to the operator.

WARNING. To avoid risk of electric shock or fire, comply with the burn limit when measuring high-frequency signals with hand-held accessories. Do not exceed the voltage or category rating of the probe or accessories (whichever is less). Keep your fingers behind the finger guard of the probe. Keep the probe body and output cable away from the circuits being measured. Use only the specified accessories.



HVD3605 / HVD3605A Differential Input Impedance



Functional Test Procedure

This procedure should be performed to confirm the basic operation of an HVD3000 or HVD3000A probe or to aid in determining the source of a problem rather than to verify the accuracy of the probe. You can perform the Functional Test without removing the probe covers.

Other than a Teledyne LeCroy oscilloscope, no special test equipment is required for the functional test.

1. Connect the probe to any oscilloscope vertical channel and open the Cn dialog.
2. Touch AUTO ZERO on the probe dialog (behind the Cn dialog).
3. If necessary, adjust the OFFSET to 0.000 V.
4. Using accessory clips, attach the red clip to the + CAL out and the black clip to the ground post of the CAL out signal. For oscilloscopes with the CAL signal on a BNC connector, a BNC-to-Banana adapter (e.g., Pomona model 1296) may beused.
5. Press AUTOSETUP.
6. Set the sensitivity of the probe to1 V/Div.
7. Set theCAL output to 1 Vp-p square wave.
8. Verify that the displayed square wave is 1 Vp-p centered at +0.5 V.
9. Reverse the accessory leads on CAL out and verify that the displayed square wave is still 1 V, but is now centered at –0.5 V.
10. Change the COUPLING on the channel setup dialog to Grounded to verify that the signal disappears and that the trace is still centered on the screen.
11. Verify that the probe attenuation shows the following:
    - x100 for HVD3102 and HVD3102A
    - x50 for HVD3106, HVD3106A, HVD3206, and HVD3206A
    - x200 for HVD3605 and HVD3605A
12. Set the VOLTS/DIV to 100 V.
13. Verify that the probe attenuation now shows:
    - x1K for HVD3102 and HVD3102A
    - x500 for HVD3106, HVD3106A, HVD3206, and HVD3206A
    - x2K for HVD3605 and HVD3605A

Performance Verification Procedure

This procedure can be used to verify the warranted characteristics of an HVD3000 or HVD3000A probe. If the product does not meet specifications, it should be returned to a . As there are no user accessible adjustments, there is no adjustment procedure.

Required Equipment

The following table lists the test equipment and accessories (or their equivalents) that are required for performance verification of the probe. This procedure is designed to minimize the number of calibrated test instruments required. Because the input and output connector types may vary on different brands and models of test instruments, additional adapters or cables may be required. Only the parameters listed in boldface in the "Minimum requirements" column must be calibrated to the accuracy indicated.

Description	Requirements	Example Equipment
Digital Multimeter	**DC: 0.1% accuracy** **AC: 0.2% accuracy to measure** 7 mVrms to 37 Vrms at 70 Hz	Agilent 34401A Fluke 8842A-09 Keithley 2001
Function Generator	Output sine wave: 20 Vpp HVD310x and HVD3602 37 Vrms HVD3605* * May require an amplifier to obtain required voltage, such as Tegam 2340.	Agilent 33120A Stanford Research DS34 Leader LAG-120B
BNC Coaxial Cable	Male-to-Male 50 Ω Cable	Pomona 5697-36
Calibration Fixture	ProBus Extender Cable	Teledyne LeCroy PROBUS-CF01
Banana Plug Adapter	Female BNC-to-Dual Banana Plug	Pomona 1269 Mueller BU-00260
Insulated Banana Plug Insulated Banana Couplers (2)	Insulated BNC-to-Shrouded Banana Plug	Mueller BU-5671-B-12-0 Mueller BU-32601-2 (R) Mueller BU-32601-6 (B)

Preliminary Procedure

1. Connect the probe under test to the female end of the ProBus Extension Cable. Connect the male end of the ProBus Extension Cable to channel 1 (C1) of the oscilloscope.
2. Turn on the oscilloscope and allow at least 30 minutes warm-up time before performing the Certification Procedure.
3. Turn on the other test equipment and allow these to warm up for the time recommended by the manufacturer.
4. While the instruments are reaching operating temperature, make a photocopy of the Performance Verification Test Record (following this topic), and fill in the necessary data.

Certification Procedure

1. Set the function generator to sine wave, 70 Hz, and an output voltage of approximately:
   - 7 Vrms (into a high impedance output) for HVD310x, HVD310xA, HVD3206, and HVD3206A
   - 37 Vrms for HVD3605 and HVD3605A
2. Set the DMM to measure AC Volts.
3. Connect the function generator output to the DMM, using a BNC cable and a female BNC to dual banana plug adapter.
4. Adjust the function generator output voltage until the DMM reads:
   - 7 V ±0.01 V for HVD310x, HVD310xA, HVD3206, and HVD3206A
   - 37 V ±0.01 V for HVD3605 and HVD3605A
5. Record the DMM reading to 1 mV resolution in the Test Record.
6. Disconnect the BNC cable from the function generator and from the BNC-to-banana plug adapter on the DMM. (Leave the banana plug adapter connected to the DMM).
7. Connect the BNC connector from the probe extender cable to the BNC-to-banana plug adapter on the DMM.
8. Connect the insulated banana plug adapter to the function generator.

9. Using the insulated banana couplers, connect the positive lead (red) of the probe under test to the positive output of the BNC-to-banana plug adapter and the negative lead (black) to the negative or return output.
10. Set the oscilloscope scale factor to:
    - 20 V/Div for HVD310x, HVD310xA, HVD3206, and HVD3206A
    - 50 V/Div for HVD3605 and HVD3605A
11. Record the DMM reading to 0.01 mV resolution in the Test Record.
12. Multiply the measured output voltage recorded in step 11 by the actual probe attenuation factor, then divide this number by the function generator output voltage (probe input voltage) recorded in step 5. Subtract 1 from this number and multiply the result by 100 to get the error in percent:

$$\%Error = \left(\frac{PrAttenuation\ x\ MeasuredOutputVoltage}{InputVoltage} - 1\right) x\ 100$$

NOTE: The actual probe attenuation can be found by using the XStreamBrowser. Follow the procedure below.

13. Record the answer to two significant places (± x.xx%) on line 13 in the Test Record.
14. Verify that the error ≤ 1.00%.
15. Decrease the oscilloscope scale factor to 5 V/Div.
16. Record the DMM reading to 0.01 mV resolution in the Test Record.
17. Multiply the measured output voltage recorded in step 16 by the actual probe attenuation factor, then divide this number by the function generator output voltage (probe input voltage) recorded in step 5. Subtract 1 from this number and multiply the result by 100 to get the error in percent.

NOTE: Recheck the actual probe attenuation in the XStreamBrowser, as it will now be a different value than in step 12. Click the Refresh button in XStreamBrowser if the previous session is still open.

18. Record the answer to two significant places (±x.xx%) on line 18 in the Test Record.
19. Verify that the error is ≤ 1.00%.
20. This completes the Performance Verification Procedure. Complete and file the Test Record as required to support your internal calibration procedure. If the criteria in steps 14 or 19 are not met,

Checking Probe Attenuation in XStreamBrowser

Probe attenuation and other values can be found by using the XStreamBrowser application that is installed with the oscilloscope firmware.

1. Choose File > Minimize to show the oscilloscope desktop, then double-click the XStreamBrowser icon.
2. From the browser menu bar, choose File > Connect to Local Instrument.
3. Navigate to LeCroy.XStreamDSO > Acquisition > C1 > InputB > HVDxxxxx (where xxxxx is your probe model number). The value is shown next to PrAttenuation.
4. Close XStreamBrowser and touch the oscilloscope icon (bottom right of desktop) to return to the oscilloscope software.

NOTE: These steps are tailored to the Performance Verification procedure. You can find any value at any time by changing the path to reflect the probe's actual input channel and row (C*n* > Input A|B).

HVD3000 / HVD3000A Test Record

Serial Number:_____

Asset / Tracking Number: _____

Date:_____

Technician:_____

Equipment	Model	Serial Number	Calibration Due Date
Oscilloscope			
Digital Multimeter			
Function Generator*			

* In this Performance Verification Procedure, the function generator is used for making relative measurements. The output of the generator is measured with a DMM or oscilloscope. Thus, the generator is not required to be calibrated.

Step	Description	Intermediate Data	Test Result
5	Function Generator Output Voltage	V	
11	Probe Output Voltage	V	
13	Gain Error (test limit ±1 %)		%
16	Probe Output Voltage	V	
18	Gain Error (test limit ±1 %)		%

Permission is granted to photocopy this page to record the results of the Performance Verfication procedure. File the completed record as required by applicable internal quality procedures.

- Line numbers correspond to steps in the procedure that require the recording of data.
- Record the actual specification limit check under "Test Result". The test limits are included in all of these steps.
- Record other measurements and intermediate calculations that support the limit check under "Intermediate Results".

Operation

Connecting to the Test Instrument

HVD3000 and HVD3000A probes have been designed for use with Teledyne LeCroy oscilloscopes equipped with the ProBus interface. When you attach the probe to the oscilloscope's input connector, the instrument will:

- Recognize the probe
- Set the oscilloscope input termination to 1 MΩ
- Activate the probe control functions in the oscilloscope user interface

NOTE: For accurate measurements, connect the probe to the oscilloscope and allow it to warm up for at least 20 minutes. When using HVD3000 probes, perform Auto Zero prior to connecting probe leads to the DUT. HVD3000A probes may be connected to the DUT during Auto Zero.

Connecting to the Test Circuit

Two inputs are available at the probe tip to connect the probe to a circuit under test. For accurate measurements, both the + and – inputs must be connected to the test circuit. Positive voltages applied to the + input (red) relative to the – input (black) will deflect the oscilloscope trace toward the top of the screen.

To maintain the probe's high performance capability, exercise care when connecting the probe. Increasing the parasitic capacitance or inductance in the input paths may introduce a "ring" or slow the rise time of fast signals. Input leads that form a large loop area will pick up any radiated electromagnetic field that passes through the loop and may induce noise into the probe inputs. Because this signal will appear as a differential mode signal, the probe's common mode rejection will not remove it. This effect can be reduced by twisting the input leads together to minimize the loop area.

WARNING. To avoid electric shock or fire, maintain the input leads in good condition. The leads have a jacket wear indicator that shows through when the jacket is excessively worn. If the white "WEAR" indicator on the input leads is visible, cease use and

High common mode rejection requires precise matching of the relative gain or attenuation in the + and – input signal paths. Mismatches in additional parasitic capacitance, inductance, delay, and a source impedance difference between the + and – signals will lower the CMRR. Therefore, it is desirable to use the same length and type of wire and connectors for both input connections. When possible, try to connect the inputs to points in

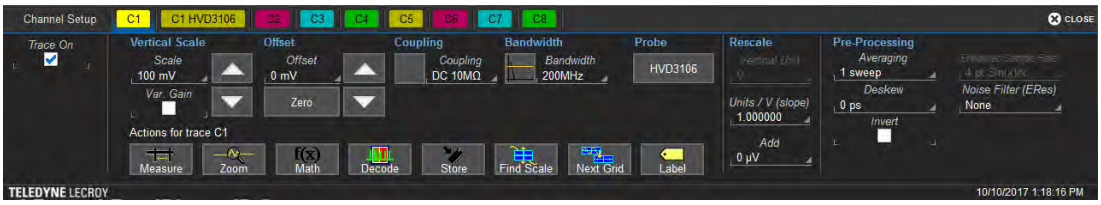
the circuit with approximately the same source impedance.

The probes may be stacked on one top of another during usage to conserve space. Since the probe body generates heat, and the stacking reduces cooling, it is recommended that ambient temperatures not exceed 30 degrees C while stacked probes are in operation. The exceptional CMRR performance should prevent interference between probes when they are stacked, but take care to separate the probe leads during operation.

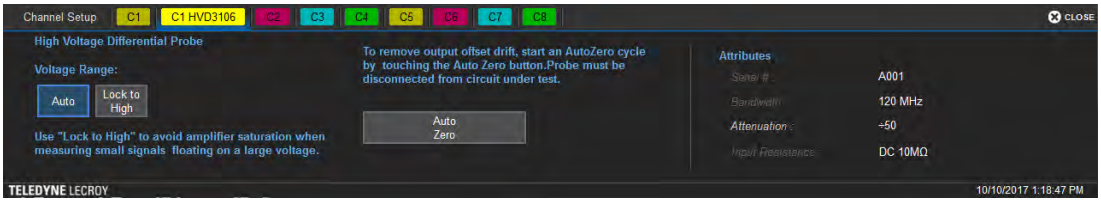
WARNING. To avoid electric shock or fire, keep the probe body and output cable away from the circuits being measured, as they cannot provide adequate protection if they come in contact with electrical sources.

Operating with an Oscilloscope

When the probe is connected to a Teledyne LeCroy oscilloscope, the displayed scale factor and measurement values will be adjusted to account for the effective gain of the probe. The probe's internal attenuation is shown on the Probe dialog, which is added to the oscilloscope's input channel dialogs when a probe is detected.



Channel setup dialog with Probe dialog behind it.



Probe dialog.

Probe Volts/Div and Attenuation

The front panel Volts/Div knob controls the oscilloscope's scale factor and the probe's internal attenuation to give full available dynamic range. Some transition of the scale factor will result in a change of attenuation.

Offset

Offset allows you to remove a DC bias voltage from the differential input signal while maintaining DC coupling. This ensures that the probe will never be overdriven while a signal is displayed on screen and prevents inaccurate measurements.

The total usable offset of the oscilloscope and probe system is a function of the oscilloscope V/div setting and offset at that V/div setting, and the probe attenuation and offset at that attenuation setting. Total maximum offset may be calculated as:

$$Oscilloscope\ Front\ \ End\ V/Div = (Probe\ and\ Oscilloscope)\ V/Div \div Probe\_Attenuation$$

Once the oscilloscope front end V/div value is known, it is possible to know the maximum oscilloscope offset available at this V/div setting either by referencing the oscilloscope specifications or setting the maximum offset value on the oscilloscope for that V/div setting. Maximum offset for the probe and oscilloscope combination can then be calculated as:

Max Positive Offset Available

$$Max\ Positive\ Offset\ \ (Probe\ and\ Oscilloscope\ together)\ =$$
$$Oscilloscope\ Positive\ Offset\ \ (at\ \ Oscilloscope\ Front\ \ End\ V/div)\ *\ \ Probe\ Attenuation - 10V$$

Max Negative Offset Available

$$Max\ Negative\ Offset\ \ (Probe\ and\ Oscilloscope\ together)\ =$$
$$Oscilloscope\ Negative\ Offset\ \ (at\ \ Oscilloscope\ Front\ \ End\ V/div)\ *\ \ Probe\ Attenuation + 10V$$

In both cases, the maximum offset available cannot exceed the following:

	X50	X100	X200	X500	X1000	X2000
3102 / 3102A	NA	±150V	NA	NA	±1500V	NA
3106 / 3106A	±150V	NA	NA	±1500V	NA	NA
3206 / 3206A	±150V	NA	NA	±1500V	NA	NA
3605 / 3605A	NA	NA	±600V	NA	NA	±6000V

NOTE: The offset values reported on oscilloscope channel descriptor boxes may deviate slightly from expected values per the formulas above. The reported probe attenuation is a "nominal" value and can deviate slightly from the actual value measured during calibration and stored with the probe. The actual offset value reported uses the actual "as measured" probe attenuation value. This provides for higher DC and low frequency gain accuracy than would otherwise be possible.

AC Coupling

In general, using offset to adjust a differential DC voltage on the screen is the preferred method to measure transient signals in the presence of a larger DC voltage. The offset has limits that will cause a signal that is beyond the linear operating range of the probe to go off the screen, preventing measurement errors.

There are times, however, when it is convenient to use AC coupling to remove the DC component of the measured signal from the measurement. Selecting AC10MΩ uses the scope AC coupling at the probe output to remove any steady state value from the displayed voltage. The maximum linear input voltage is as follows:

	X50 <7 V/div	X100 <7 V/div	X200 <28 V/div	X500 >7 V/div	X1000 >7 V/div	X2000 >28 V/div
3102 / 3102A	NA	200 Vpk	NA	NA	1750 Vpk	NA
3106 / 3106A	200 Vpk	NA	NA	2000 Vpk	NA	NA
3206 / 3206A	200 Vpk	NA	NA	2000 Vpk	NA	NA
3605 / 3605A	NA	NA	760 Vpk	NA	NA	7600 Vpk

NOTE: Because AC coupling is on the probe output, DC voltages beyond the probe's linear range will cause the amplifier to saturate and inaccurately render the displayed waveform. Do not exceed the maximum linear input value when using AC coupling.

Bandwidth Limiting

To comply with various test standards used for quantifying output noise of power supplies, the probe is capable of switching the bandwidth limit from Off (maximum bandwidth) to 20 MHz in the channel Vertical Adjust dialog.

Voltage Range

On oscilloscopes running XStreamDSO v.8.5.x.x and higher, there are two options as to how the probe will set attenuation relative to the oscilloscope's V/div setting:

Auto will automatically raise the attenuation when the V/div setting is >7.9V/div or lower the attenuation when the V/div is <7.9V/div. As a result the probe can automatically adjust attenuation to properly view the input waveform.

Lock to High locks the attenuation setting to the highest attenuation, regardless of the V/div setting. Maintaining a high attenuation will allow small signals on a larger voltage waveform to be accurately measured.

Overload Indicator (A models only)

On HVD3000A probes, an indication will appear in the oscilloscope message bar when the differential or common mode voltages are beyond the operating ranges of the probe. Note that the warning message below may trigger before any saturation occurs. It is designed to guarantee that the system will not fail to indicate an overload.

Overload Indicator Thresholds

3102A	X1000 Attenuation	X100 Attenuation
	Differential Mode: ± 1.78 kV Common Mode: ± 1.78 kV	Differential Mode: ± 158 V Common Mode: ± 1.8k V
3206A	**X500 Attenuation**	**X50 Attenuation**
	Differential Mode: ± 2.1 kV Common Mode: ± 2.1 kV	Differential Mode: ± 180 V Common Mode: ± 2.1 kV
3605A	**X2000 Attenuation**	**X200 Attenuation**
	Differential Mode: ± 7.7 kV Common Mode: ± 7.7 kV	Differential Mode: ± 760 V Common Mode: ± 7.7 kV

Auto Zero

Auto Zero corrects for DC offset drifts that naturally occur from thermal effects in the differential amplifier. For example, the DC offset drift of the HVD310x and HVD310xA probes is 70 µV/°C (worst case) referred to the output. If the probe is set to 50x attenuation and the ambient temperature changes by 10 °C, the DC offset drift could be as high as (70 µV/°C)(50)(10 °C) = 35 mV referred to the probe tip. If measuring a 3 Vp-p signal, the DC offset drift could be a little more than 1%. If the signal was 1400 Vp-p in 500x attenuation mode, the DC offset drift at same ambient temperature could be as high as (70 µV/°C)(500)(10°C) = 350 mV due to the probe tip (although any offset accuracy error from the oscilloscope itself would likely dominate the measurement).

Auto Zero is invoked manually from the Probe dialog that appears behind the Channel setup dialog when the probe is connected to the oscilloscope.

NOTE: When using HVD3000 probes, disconnect the probe from the test circuit before performing Auto Zero. HVD3000A probes may remain connected during Auto Zero.

Always perform Auto Zero after the probe has been warmed-up (20 min. recommended). Depending on the measurement accuracy desired and/or the change in the ambient temperature where the probe is located, it may be necessary to perform Auto Zero more often. If the probe is disconnected from the oscilloscope then re-connected, repeat Auto Zero after a suitable warm-up time.

Auto Zero is disabled when AC coupling is selected.

Maintenance

Cleaning

Clean only the exterior surfaces of the device using a soft cloth or swab dampened with water or 75% isopropyl alcohol solution. Do not use harsh chemicals or abrasive cleansers. Dry the probe and accessories thoroughly before making any voltage measurements.

CAUTION. The probes are not waterproof. Under no circumstances submerge the probe in liquid or allow moisture to penetrate it.

Calibration Interval

This probe has no adjustments. The recommended calibration interval is one year. A Performance Verification Procedure is included in this manual.

Service Strategy

HVD3000 and HVD3000A probes utilize fine-pitch surface mount devices. It is, therefore, impractical to attempt repair in the field. Defective probes must be returned to a

CAUTION. Do not remove the covers. Refer all servicing to qualified personnel. A defective probe under warranty will be replaced with a factory refurbished probe.

A probe that is not under warranty can be exchanged for a factory refurbished probe for a modest fee. Replacement probes are factory repaired, inspected, and calibrated to the same standards as a new product. You must return the defective probe in order to receive credit for the probe core.

Replacement Parts

Replacement probe accessories can be ordered through your local sales office:

Probe	Replacement Parts	Part Number
HVD310x / HVD310xA	Probe Accessory Kit *	PK-HV-001
HVD3206 / HVD3206A	2kV Alligator Clips	PK-HVA-07
HVD3605 / HVD3605A	6kV Alligator Clips	PK-HVA-06

* Individual probe accessory tips can be purchased through your regional service center. Refer to the accessory part numbers listed earlier in this manual.

Reference

Common Mode Rejection Ratio

The ideal differential probe/amplifier would sense and amplify only the differential mode voltage component and reject the entire common mode voltage component. Real differential amplifiers are not perfect, and a small portion of the common mode voltage component appears at the output.

Common Mode Rejection Ratio (CMRR) is the measure of how much the amplifier rejects the common mode voltage component. CMRR is equal to the differential mode gain (or normal gain) divided by the common mode gain. Common mode gain is equal to the output voltage divided by the input voltage when both inputs are driven by only the common mode signal. CMRR can be expressed as a ratio (e.g., 10,000:1) or implicitly in dB (e.g., 80 dB). Higher numbers indicate greater rejection (better performance).

The first order term determining the CMRR is the relative gain matching between the + and – input paths. Obtain high CMRR values by precisely matching the input attenuators in a differential amplifier. The matching includes the DC attenuation and the capacitance which determines the AC attenuation. As the frequency of the common mode component increases, the effects of stray parasitic capacitance and inductance in determining the AC component become more pronounced. The CMRR becomes smaller as the frequency increases. Therefore, the CMRR is usually specified in a graph of CMRR versus common mode frequency.

The common mode frequency in these graphs is assumed to be sinusoidal. In real life applications, the common mode signal is seldom a pure sine wave. Signals with pulse wave shapes contain frequency components much higher than the repetition rate may suggest. This makes it very difficult to predict actual performance in the application for CMRR-versus- frequency graphs. The practical application of these graphs is to compare the relative common mode rejection performance between different probes and amplifiers.

Differential Mode and Common Mode

Differential probes sense the voltage difference that appears between the **+** and **–** inputs. This is referred to as the Differential or Normal Mode voltage. The voltage component that is referenced to earth and is identical on both inputs is rejected by the amplifier. This is referred to as the Common Mode voltage and can be expressed as:

$$V_{CM} = \frac{V_{+input} + V_{-input}}{2}$$

Differential Mode Range and Common Mode Range

Differential Mode range is the maximum signal that can be applied between the **+** and **-** inputs without overloading the amplifier, which otherwise would result in clipping or distorting of the waveform measured by the oscilloscope.

The Common Mode Range is the maximum voltage with respect to earth ground that can be applied to either input. Exceeding the common mode range can result in unpredictable measurements. Because the Common Mode signal is normally rejected, and not displayed on the oscilloscope, be careful to avoid accidentally exceeding the common mode range.

IEC/EN 61010-031 Definitions

IEC/EN 61010-031/A1:2008

Measurement Category III (CAT III) applies to test and measuring circuits connected to the distribution part of the building's low-voltage mains installation.

Measurement Category II (CAT II) applies to test and measuring circuits connected directly to utilization points (socket outlets and similar points) of the low-voltage mains installation.

Measurement Category I (CAT I) applies to test and measurement circuits that are not intended to be directly connected to the mains supply.

Pollution Degree 2 refers to an operating environment where normally only dry non-conductive pollution occurs. Conductivity caused by temporary condensation should be expected.

IEC/EN 61010-031:2015

Measurement Category III (CAT III) applies to test and measuring circuits connected to the distribution part of the building's low-voltage mains installation.

Measurement Category II (CAT II) applies to test and measuring circuits connected directly to utilization points (socket outlets and similar points) of the low-voltage mains installation.

No Rated Measurement Category applies to other circuits that are not directly connected to the mains supply.

Pollution Degree 2 refers to an operating environment where normally only dry non-conductive pollution occurs. Conductivity caused by temporary condensation should be expected.

NOTE: The 2015 version of the standard eliminates the Measurement Category I (CAT I) rating for test and measuring circuits that are not intended to be directly connected to the mains supply. However, this change in rating designation does not reduce the measurement capability or the level of protection offered by the new probe design when compared to the probes that were originally certified per the 2008 version of the standard.

Certifications

Teledyne LeCroy certifies compliance to the following standards as of the time of publication. As standards evolve, these certifications may no longer be current. Please see the EC Declaration of Conformity certificate shipped with your product.

EMC Compliance

EC Declaration of Conformity - EMC

The probe meets the intent of EC Directive 2014/30/EU for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

EN 61326-1:2013, EMC requirements for electrical equipment for measurement, control, and laboratory use.[1, 2, 3]

1. This product is intended for use in nonresidential areas only. Use in residential areas may cause EM interference.
2. Emissions exceeding the levels required by this standard may occur when product is connected to a test object.
3. To ensure compliance with the applicable EMC standards, use high quality shielded interface cables.

Australia & New Zealand Declaration of Conformity—EMC

The probe complies with the EMC provision of the Radio Communications Act per the following standards, in accordance with requirements imposed by Australian Communication and Media Authority (ACMA):

AS/NZS CISPR 11:2011 Radiated and Conducted Emissions, Group 1, Class A.

Safety Compliance

EC Declaration of Conformity - Low Voltage

The probe meets the intent of EC Directive 2014/35/EU for Product Safety. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

IEC/EN 61010-031:2015 Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 031: Safety requirements for hand-held probe assemblies for electrical measurement and test.

U.S. Nationally Recognized Agency Certification

The probe has been certified by Underwriters Laboratories (UL) to conform to the following safety standard and bears UL Listing Mark:

UL 61010-031-2015 (Second Edition) - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 031: Safety Requirements for Hand-Held Probe Assemblies for Electrical Measurement and Test.

Canadian Certification

The probe has been certified by Underwriters Laboratories (UL) to conform to the following safety standard and bears cUL Listing Mark:

CAN/CSA-C22.2 No. 61010-031-15 - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 031: Safety Requirements for Hand-Held Probe Assemblies for Electrical Measurement and Test.

Environmental Compliance

End-of-Life Handling

The product is marked with this symbol to indicate that it complies with the applicable European Union requirements to Directives 2012/19/EU and 2013/56/EU on Waste Electrical and Electronic Equipment (WEEE) and Batteries.

The product is subject to disposal and recycling regulations that vary by country and region. Many countries prohibit the disposal of waste electronic equipment in standard waste receptacles. For more information about proper disposal and recycling of your Teledyne LeCroy product,

Restriction of Hazardous Substances (RoHS)

The product and its accessories conform to the 2011/65/EU RoHS2 Directive.